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NASA Procedural Requirements

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Subject: NASA Systems Engineering Processes and Requirements (w/Change 1)

Responsible Office: Office of the Chief Engineer

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Chapter 2. Institutional and Programmatic Requirements

2.1 Roles and Responsibilities Relative to System Engineering Practices

2.1.1 General

The roles and responsibilities of senior management are defined in part in NPD 1000.0 and NPD 7120.4. The roles and responsibilities of program and project managers are defined in NPR 7120.5, NPR 7120.7, NPR 7120.8, NPR 8820.2, and other NASA directives. This NPR establishes SE processes and responsibilities.

2.1.1.1 For programs and projects involving more than one Center, the governing Mission Directorate or mission support office determines whether a Center executes a program/project in a lead role or in a supporting role. For Centers in supporting roles, compliance to this NPR should be jointly negotiated and documented in the lead Center's program/project SEMP or other equivalent program/project documentation along with approval through the lead Center's ETA process.

2.1.1.2 The roles and responsibilities associated with program and project management and Technical Authority (TA) are defined in the Program and Project Management NPRs (for example, NPR 7120.5 for space flight projects). Specific roles and responsibilities of the program/project manager and the ETA related to the SEMP are defined in Sections 2.1.6 and 6.2 of this NPR.

2.1.2 Office of the Chief Engineer (OCE)

2.1.2.1 The NASA Chief Engineer is responsible for policy, oversight, and assessment of the NASA engineering and program/project management process; implements the ETA process; and serves as principal advisor to the Administrator and other senior officials on matters pertaining to the Agency's technical capability and readiness to execute NASA programs and projects.

2.1.2.2 The NASA Chief Engineer provides overall leadership for the ETA process for programs and projects, including Agency engineering policy direction, requirements, and standards. The NASA Chief Engineer hears appeals of engineering decisions when they cannot be resolved at lower levels.

2.1.3 Mission Directorate or Headquarters Program Offices

2.1.3.1 The Mission Directorate Associate Administrator (MDAA) is responsible for establishing, developing, and maintaining the Programmatic Authority (i.e., policy and procedures, programs, projects, budgets, and schedules) in managing programs and projects within their Mission Directorate.

2.1.3.2 When programs and projects are managed at Headquarters or within Mission Directorates, that program office is responsible for the requirements in this NPR. Technical teams residing at Headquarters will follow the requirements of this NPR unless tailored by the governing organization and responsible ETA. The technical teams residing at Centers will follow Center-level process requirement documents.

2.1.3.3 The Office of the Chief Information Officer provides leadership, planning, policy direction, and oversight for the management of NASA information and NASA information technology (IT).

2.1.4 Center Directors

2.1.4.1 The Center Director is responsible for establishing, developing, and maintaining the Institutional Authority (e.g., processes and procedures, human capital, facilities, and infrastructure) required to execute programs and projects assigned to their Center. This includes:

- a. Ensuring the Center is capable of accomplishing the programs, projects, and other activities assigned to it in accordance with Agency policy and the Center's best practices and institutional policies by establishing, developing, and maintaining institutional capabilities (processes and procedures, human capital—including trained/certified program/project personnel, facilities, and infrastructure) required for the execution of programs and projects.
- b. Performing periodic program and project reviews to assess technical and programmatic progress to ensure performance in accordance with their Center's and the Agency requirements, procedures, processes, and other documentation.
- c. Working with the Mission Directorate and the program and project managers, once assigned, to assemble the program/project team(s) and to provide needed Center resources.
- d. Providing support and guidance to programs and projects in resolving technical and programmatic issues and risks.

2.1.4.2 The Center Director is responsible for developing the Center's ETA policies and practices consistent with Agency policies and standards. The Center Director is the Center ETA responsible for Center engineering design processes, specifications, rules, best practices, and other activities necessary to fulfill mission performance requirements for programs, projects, and/or major systems implemented by the Center. The Center Director delegates the Center ETA implementation responsibility to an individual in the Center's engineering leadership. The Center ETA supports processing changes to, and waivers or deviations from, requirements that are the responsibility of the ETA. This includes all applicable Agency and Center engineering directives, requirements, procedures, and standards.

Note: Centers may employ and tailor relevant government or industry standards that meet the intent of the requirements established in this NPR to augment or serve as the basis for their processes. A listing of endorsed technical standards is maintained on the NASA Technical Standards System under "Endorsed Standards" https://standards.nasa.gov/endorsed_standards.

2.1.4.3 [SE-01] through [SE-05] deleted.

Note: Rather than resequence the remaining requirements, the original requirement numbering was left intact in case Centers or other organizations refer to these requirement numbers in their flow-down requirement documents. Appendix J is provided to account for the deleted requirements. For each requirement that was deleted, the justification for its deletion is noted.

2.1.5 Technical Teams

2.1.5.1 Systems engineering is implemented by the technical team in accordance with the program/project SEMP or other equivalent program/project documentation. The makeup and organization of each technical team is the responsibility of each Center or program and includes all the personnel required to implement the technical aspects of the program/project.

2.1.5.2 The technical team, in conjunction with the Center's ETA, is responsible for completing the compliance matrix in Appendix H, capturing any tailoring, and including it in the SEMP or other equivalent program/project documentation.

2.1.5.3 For systems that contain software, the technical team ensures that software developed within NASA, or acquired from other entities, complies with NPR 7150.2.

a. NPR 7150.2 elaborates on the requirements in NPR 7123.1 and determines the applicability of requirements based on the Agency's software classification.

b. NPD 7120.4 contains additional Agency principles for the acquisition, development, maintenance, and management of software.

2.1.5.4 The technical team ensures that human systems integration activities, products, planning, and execution align with NASA/SP-2015-3709, Human Systems Integration (HSI) Practitioner's Guide.

2.1.6 Engineering Technical Authority

2.1.6.1 The ETA establishes and is responsible for the engineering design processes, specifications, rules, best practices, and other activities necessary to fulfill programmatic mission performance requirements. Centers delegate ETA to the level appropriate for the scope and size of the program/project, which may be Center engineering leadership or individuals. When ETA is used in this document, it refers generically to different levels of ETA.

2.1.6.2 ETAs or their delegates at the program or project level:

- a. Serve as members of program or project control boards, change boards, and internal review boards.
- b. Work with the Center management and other TA personnel to ensure that the quality and integrity of program or project processes, products, and standards of performance related to engineering, SMA, and health and medical reflect the level of excellence expected by the Center and the TA community.
- c. Ensure that requests for waivers or deviations from ETA requirements are submitted to, and acted on, by the appropriate level of ETA.
- d. Assist the program or project in making risk-informed decisions that properly balance technical merit, cost, schedule, and safety across the system.
- e. Provide the program or project with the ETA view of matters based on their knowledge and experience and raise needed dissenting opinions on decisions or actions. (See Dissenting Opinion Sections of NPR 7120.5, NPR 7120.8, and NPR 7120.7.)
- f. Serve as an effective part of NASA's overall system of checks and balances.

2.1.6.3 The ETA for the program or project leads and manages the system engineering activities. (Note that these responsibilities can be delegated by the ETA to Chief Engineer or other personnel as needed). A Center may have more than one engineering organization and delegates ETA to different areas as needed. The ETA may be delegated as appropriate to the size, complexity, and type of program/project. For example, ETA may be delegated to a line manager that is independent of the project for smaller projects or to the CIO for purely IT projects.

2.1.6.4 To support the program/project and maintain ETA independence and an effective check and balance system, the ETA:

- a. Will seek concurrence by the program/project manager when a program/project-level ETA is appointed.
- b. Cannot approve a request for a waiver or deviation from a non-technical derived requirement established by a Programmatic Authority.
- c. May approve a request for a waiver or deviation from a technical derived requirement if he/she ensures that the appropriate independent Institutional Authority subject matter expert who is the steward for the involved technology, has concurred in the decision to approve the requirement waiver.

2.1.6.5 Although a limited number of individuals make up the ETA, their work is enabled by the contributions of the program's or project's working-level engineers and other supporting personnel (e.g., contracting officers). The working-level engineers do not have formally delegated Technical Authority and consequently may not serve in an ETA capacity. These engineers perform the detailed engineering and analysis for the program/project with guidance from their Center management and/or lead discipline engineers and support from the Center engineering infrastructure. They deliver the program/project products (e.g., hardware, software, designs, analysis, and technical alternatives) that conform to applicable programmatic, Agency, and Center requirements. They are responsible for raising issues to the program/project manager, Center engineering management, and/or the program/project ETA and are a key resource for resolving these issues.

2.1.6.6 Requirement [SE-06] concerning SEMP approval was moved to Section 6.1.8.

2.2 Tailoring and Customizing

Tailoring can be differentiated from customizing as described in NASA/SP-2016-6105. Tailoring is removing requirements by use of waiver or deviation. Customizing is meeting the intent of the requirement through alternative approaches and does not require waivers or deviations.

2.2.1 Tailoring SE Requirements

2.2.1.1 SE requirements tailoring is the process used to seek relief from SE NPR requirements when that relief is consistent with program or project objectives, acceptable risk, and constraints.

2.2.1.2 The tailoring process (which can occur at any time in the program or project life cycle) results in deviations or waivers to requirements depending on the timing of the request (see Appendix A for definition of deviation and waiver).

2.2.1.3 The results of the program/project technical team's tailoring SE requirements from either this NPR, or a particular Center's implementation of this NPR, will be documented in the SEMP or other equivalent project documentation, along with supporting rationale that includes the risk evaluation, and documented approvals through the Center's ETA process.

2.2.2 Customizing SE Practices

2.2.2.1 Customizing is the adaptation of SE practices that are used to accomplish the SE requirements as appropriate to the size, complexity, and acceptable risk of the program/project.

2.2.2.2 Technical teams under the guidance of the project ETA are encouraged to customize these recommended SE practices so that the intent of the SE practice is being met in the most effective and efficient manner. The results of this customization do not require waivers or deviations but should be documented in the program/project SEMP or other equivalent program/project documentation.

2.2.3 Considerations for Tailoring or Customizing

Refer to NASA, SP-2016-6105 for examples of tailoring and customizing.

2.2.3.1 Considerations for tailoring or customizing should include but are not limited to:

- a. Scope and visibility (e.g., organizations and partnerships involved, international agreements, amount of effort required).
- b. Risk tolerance and failure consequences.
- c. System size, functionality, and complexity (e.g., human space flight/flagship science vs. subscale technology demonstration).
- d. Human involvement (e.g., human interfaces, critical crew (flight, ground) functions, interaction with, and control/oversight of (semi-) autonomous systems).
- e. Impact on Agency IT security and national security.
- f. Impact on other systems.
- g. Longevity.
- h. Serviceability (both ground and in-flight).
- i. Constraints (including cost, schedule, degree of insight/oversight permitted with partnerships or international agreements).
- j. Safety, quality, and mission assurance.
- k. Current level of technology available.
- l. Availability of industrial capacity.

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